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Scharfenberger

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(54) **VOLTAGE BLOCK**

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B05B 5/025 (2006.01)

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(58) **Field of Classification Search** 239/3, 239/104, 112, 303–305, 690, 699, 700, 708; 118/621, 627, 6; 137/625.2, 625.43
See application file for complete search history.

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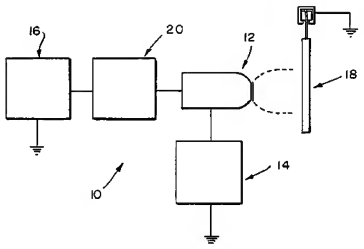
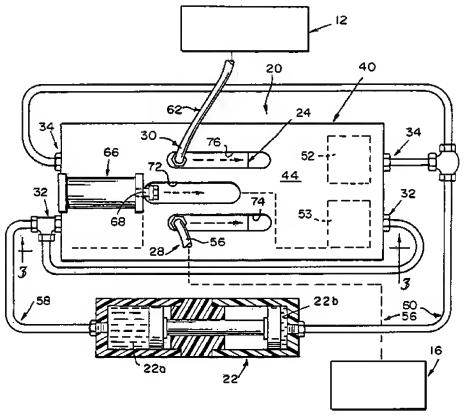
(57) **ABSTRACT**

A voltage block comprises first and second reservoirs and a switching device including an inlet port, an outlet port, a first reservoir port and a second reservoir port. The switching device is mounted in a third reservoir for movement between a first position and a second position. The third reservoir includes an electrically non-conductive fluid medium in which at least a portion of the switching device is immersed.

20 Claims, 3 Drawing Sheets





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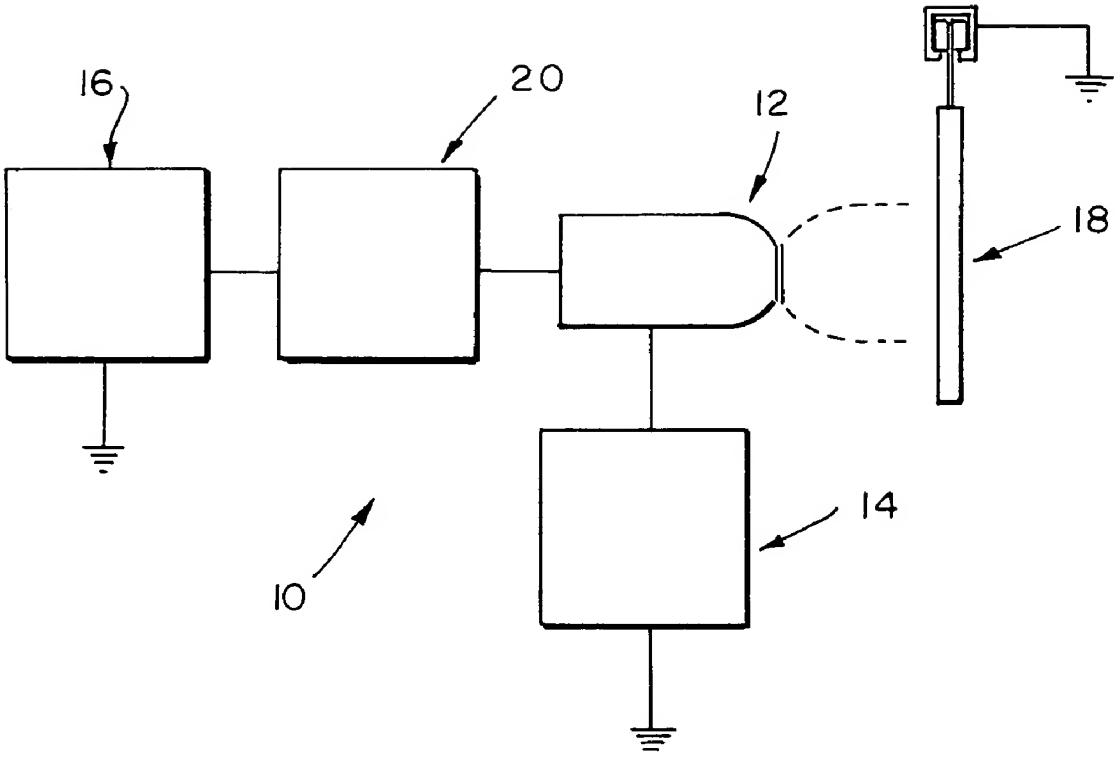
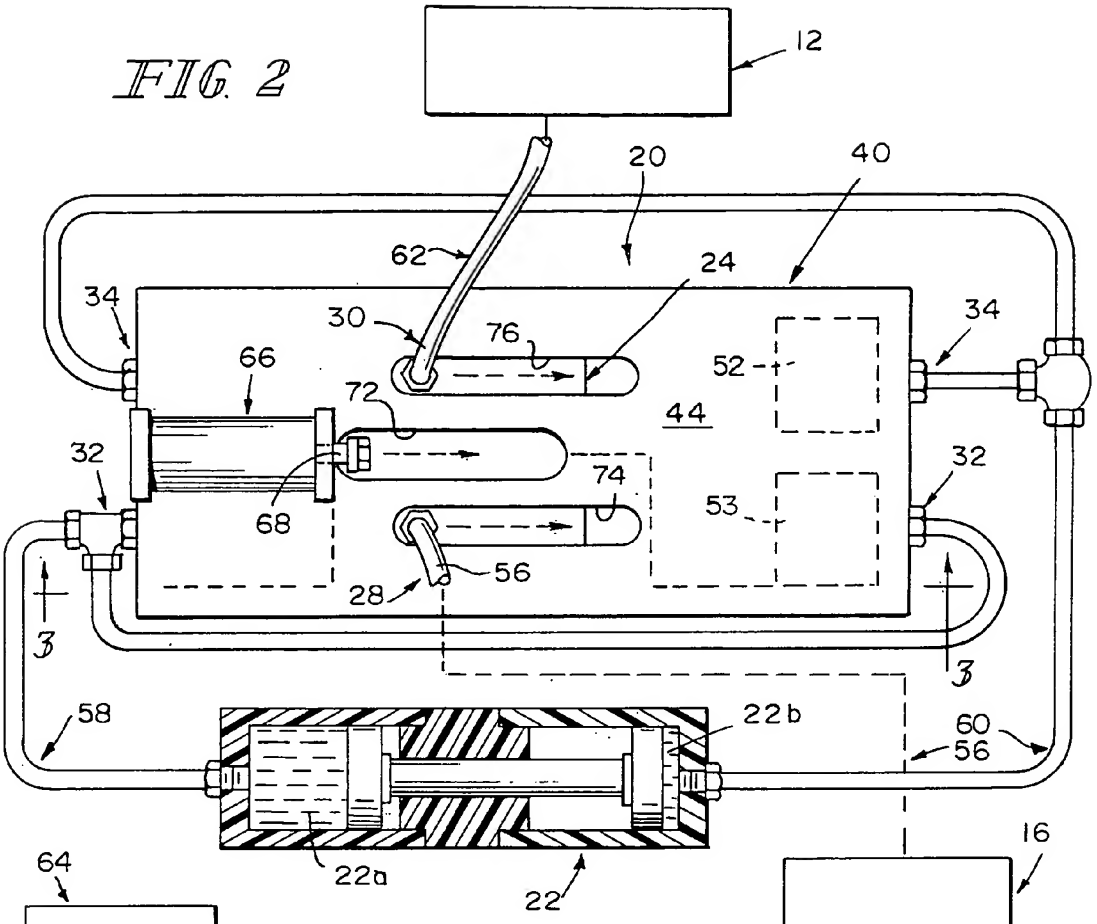


FIG. 1

FIG. 2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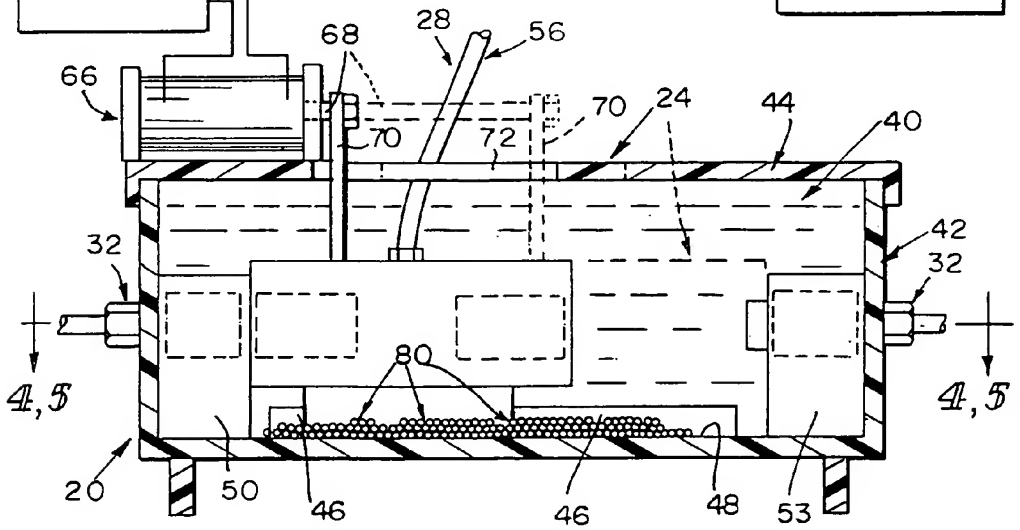
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FIG. 3

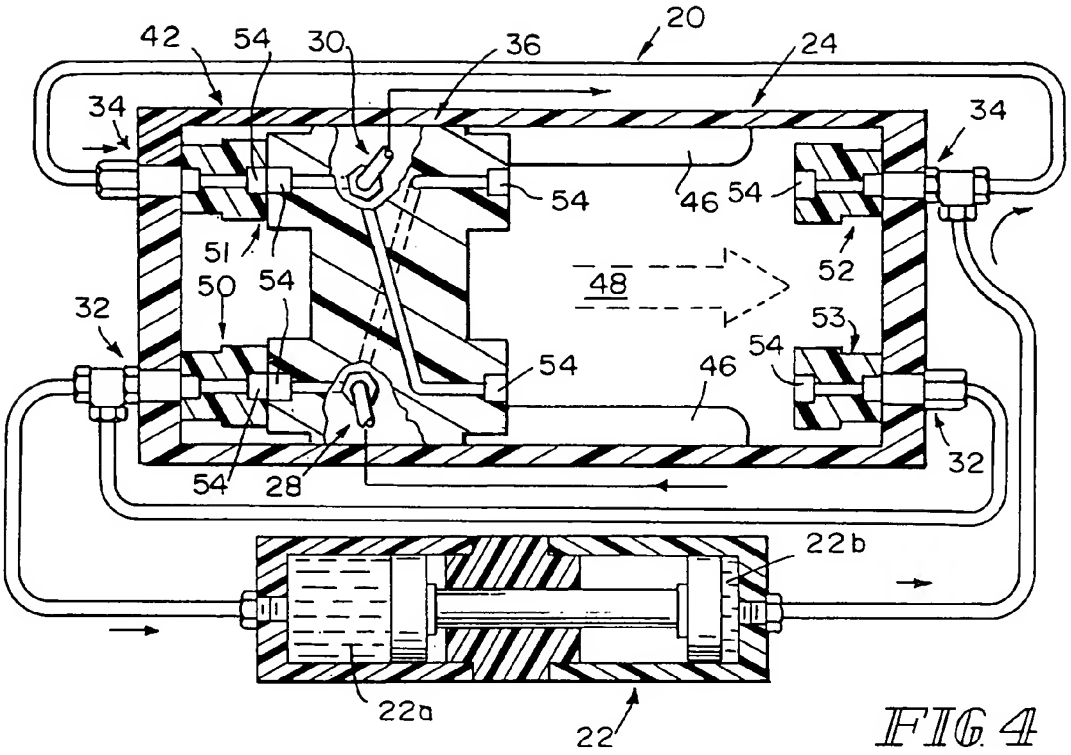
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FIG 4

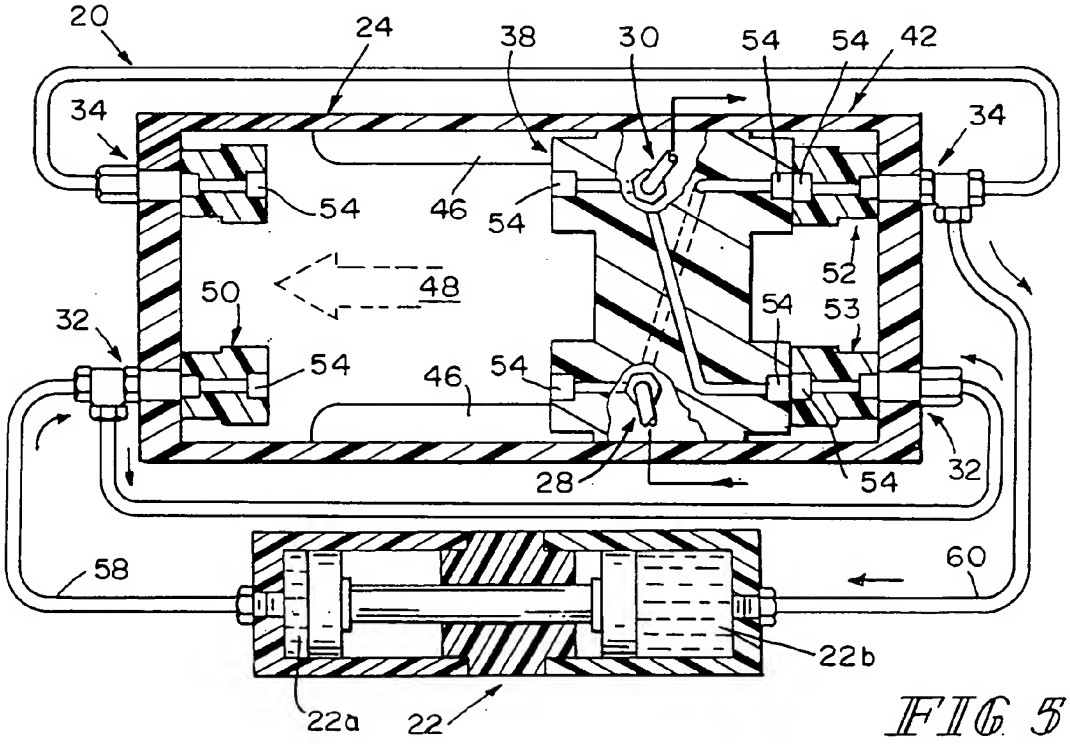
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FIG 5

VOLTAGE BLOCK

FIELD OF THE INVENTION

This invention relates to devices for electrically isolating coating dispensing equipment which is maintained at high-magnitude electrostatic potential from coating material sources supplying the coating dispensing equipment. Such devices are commonly known, and are generally referred to hereinafter, as voltage blocks.

BACKGROUND OF THE INVENTION

Various types of voltage blocks are known. There are, for example, the devices and systems described in the following U.S. Pat. Nos. 6,423,143; 6,021,965; 5,944,045; RE35,883; 5,787,928; 5,759,277; 5,746,831; 5,737,174; 5,727,931; 5,725,150; 5,707,013; 5,655,896; 5,632,816; 5,549,755; 5,538,186; 5,526,986; 5,518,186; 5,341,990; 5,340,289; 5,326,031; 5,288,029; 5,271,569; 5,255,856; 5,221,194; 5,208,078; 5,197,676; 5,193,750; 5,096,126; 5,094,389; 5,078,168; 5,033,942; 4,982,903; 4,932,589; 4,921,169; 4,884,752; 4,879,137; 4,878,622; 4,792,092; 4,771,729; 4,383,644; 4,313,475; 4,275,834; 4,085,892; 4,020,866; 4,017,029; 3,937,400; and, 3,933,285; as well as WO 2005/014178; GB2,166,982; JP4-267961; JP4-200662; JP7-88407; JP51-54638; JP54-101843; JP4-66149; JP3-178354; JP3217394 and, JP3378058. U.S. Pat. No. 4,337,282 is also of interest. The disclosures of these references are hereby incorporated herein by reference. This listing is not intended to be a representation that a complete search of all relevant art has been made, or that no more pertinent art than that listed exists, or that the listed art is material to patentability. Nor should any such representation be inferred.

DISCLOSURE OF THE INVENTION

According to an aspect of the invention, a voltage block comprises first and second reservoirs and a switching device including an inlet port, an outlet port, a first reservoir port and a second reservoir port. The switching device is mounted in a third reservoir for movement between a first position and a second position. The third reservoir includes an electrically non-conductive fluid medium in which at least a portion of the switching device is immersed.

Illustratively according to this aspect of the invention, the voltage block includes first, second, third and fourth valves. The first, second, third and fourth valves are immersed in the electrically non-conductive fluid medium.

Illustratively according to this aspect of the invention, the first and second reservoirs comprise piston-and-cylinder fluid motors.

Illustratively according to this aspect of the invention, the first and second reservoirs together comprise a double-acting, piston-and-cylinder fluid motor.

Illustratively according to this aspect of the invention, the third reservoir comprises a tank including a track to which the switching device is mounted for movement between the first and second positions.

Illustratively according to this aspect of the invention, when the switching device is in the first position, the first valve couples the inlet port to the first reservoir port and the second valve couples the second reservoir port to the outlet port, and when the switching device is in the second position, the third valve couples the inlet port to the second reservoir port and the fourth valve couples the first reservoir port to the outlet port.

Illustratively according to this aspect of the invention, the third reservoir includes means for movably mounting the switching device. The voltage block further includes means for moving the switching device between the first and second positions.

Further illustratively according to this aspect of the invention, the voltage block comprises molecular sieves in the third reservoir for separating a component it is desired to remove from the electrically non-conductive fluid medium.

Additionally illustratively according to this aspect of the invention, the molecular sieves are renewable.

According to another aspect of the invention, the voltage block appears in combination in a coating dispensing system with a coating material source, a coating dispensing device, a high magnitude electrostatic potential source. A first conduit couples the source and the inlet port. A second conduit couples the first reservoir and first reservoir port. A third conduit couples the second reservoir and second reservoir port. A fourth conduit couples the outlet port and the coating dispensing device.

According to another aspect of the invention, a method of coating an article comprises providing first and second reservoirs and providing a switching device. An inlet port, an outlet port, a first reservoir port and a second reservoir port are provided on the switching device. The method further includes providing a third reservoir including an electrically non-conductive fluid medium. The switching device is mounted in the third reservoir for movement between a first position and a second position. The switching device is at least partially immersed in the electrically non-conductive fluid medium in the third reservoir.

Illustratively according to this aspect of the invention, providing a switching device and providing a third reservoir together include providing first, second, third and fourth valves. At least partially immersing the switching device in the electrically non-conductive fluid medium in the third reservoir includes immersing the first, second, third and fourth valves in the electrically non-conductive fluid medium.

Illustratively according to this aspect of the invention, providing first and second reservoirs comprises providing piston-and-cylinder fluid motors.

Illustratively according to this aspect of the invention, providing first and second reservoirs together comprises providing a double-acting, piston-and-cylinder fluid motor.

Illustratively according to this aspect of the invention, providing the third reservoir comprises providing a tank including a track. Providing the switching device includes mounting the switching device on the track for movement between the first and second positions.

Illustratively according to this aspect of the invention, the method further includes coupling the inlet port to the first reservoir port through the first valve and coupling the second reservoir port to the outlet port through the second valve when the switching device is in the first position, and coupling the inlet port to the second reservoir port through the third valve and coupling the first reservoir port to the outlet port through the fourth valve when the switching device is in the second position.

Further illustratively according to this aspect of the invention, the method includes movably mounting the switching device and moving the switching device between the first and second positions.

Illustratively according to this aspect of the invention, the method further comprises providing molecular sieves in the third reservoir for separating a component it is desired to remove from the electrically non-conductive fluid medium.

Additionally illustratively according to this aspect of the invention, the method further comprises renewing the molecular sieves.

According to another aspect of the invention, the method includes providing a coating material source, a coating dispensing device, and a high magnitude electrostatic potential source, coupling the source and the inlet port, coupling the first reservoir and first reservoir port, coupling the second reservoir and second reservoir port, and coupling the outlet port and the coating dispensing device.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention may best be understood by referring to the detailed description and accompanying drawings which illustrate the invention. In the drawings:

FIG. **1** illustrates a partly block and partly schematic diagram of a system constructed according to the present invention;

FIG. **2** illustrates an enlarged, partly plan and partly sectional view of certain components of the system illustrated in FIG. **1**;

FIG. **3** illustrates a partly sectional side elevational view of the components illustrated in FIG. **2**, taken generally along section lines **3-3** thereof;

FIG. **4** illustrates a partly sectional view of the components illustrated in FIGS. **2-3**, taken generally along section lines **4**, **5-4**, **5** of FIG. **3**, in a first position; and,

FIG. **5** illustrates a partly sectional view of the components illustrated in FIGS. **2-4**, taken generally along section lines **4**, **5-4**, **5** of FIG. **3**, in a second position.

DETAILED DESCRIPTIONS OF ILLUSTRATIVE EMBODIMENTS

As used in this application, terms such as "electrically conductive" and "electrically non-insulative" refer to a broad range of conductivities electrically more conductive than materials described as "electrically non-conductive" and "electrically insulative." Terms such as "electrically semiconductive" refer to a broad range of conductivities between electrically conductive and electrically non-conductive.

Referring now first to FIG. **1**, an electrostatic coating system **10** comprises a coating dispensing device **12**, such as, for example, one of the general type illustrated in any of the above-identified patents and published applications. Coating dispensing device **12** is coupled to a source **14** of high magnitude electrostatic potential in the range of, for example, −35 KVDC to −110 KVDC. Source **14** illustratively is one of the general type illustrated and described in U.S. Pat. Nos. 6,562,137; 6,423,142; 6,144,570; 5,978,244; 5,159,544; 4,745,520; 4,485,427; 4,481,557; 4,324,812; 4,187,527; 4,075,677; 3,894,272; 3,875,892; and, 3,851,618. The disclosures of these references are hereby incorporated herein by reference. This listing is not intended to be a representation that a complete search of all relevant art has been made, or that no more pertinent art than that listed exists, or that the listed art is material to patentability. Nor should any such representation be inferred.

A source **16** of coating material to be dispensed and an object **18** to be coated by the dispensed coating material are both coupled to reference potential, hereinafter sometimes ground. The source **16** typically includes means, such as a pump or compressed air source, for supplying the coating material at a desired pressure. The coating material itself will typically be an electrically non-insulative, for example, water-base, coating material, requiring that a voltage block be placed in the circuit between the coating material source **16** and the coating dispensing device **12** coupled to potential source **14**. The source **16** is coupled through a voltage block **20** according to the invention to the dispensing device **12**.

Referring now more particularly to FIGS. **2-5**, the voltage block **20** includes a double-acting, piston-and-cylinder fluid motor **22** defining first and second reservoirs **22***a* and **22***b*, and a switching device **24**. Switching device **24** includes an inlet port **28**, an outlet port **30**, and first and second reservoir ports **32**, **34**. Switching device **24** is selectively movable between a first position **36** illustrated in FIGS. **2-4** in which inlet port **28** is coupled to first reservoir port **32** and second reservoir port **34** is coupled to outlet port **30**, and a second position **38** illustrated in FIG. **5** in which inlet port **28** is coupled to second reservoir port **34** and first reservoir port **32** is coupled to outlet port **30**. The construction and operation of reservoirs **22***a-b* and switching device **24** may be generally as illustrated and described in WO 2005/014178.

The switching device **24** is itself mounted in a reservoir **40** illustrated in FIGS. **2-3**. Reservoir **40** is constructed from electrically non-conductive material such as, for example, filled or unfilled resin or polymer material. Illustratively, fluid motor **22**, switching device **24** and reservoir **40** are all constructed from a suitable electrically non-conductive, filled or unfilled Delrin® acetal resin. Switching device **24** may contain some metallic elements. For example, various valves of the switching device **24** may have some metal components. However, by virtue of such metal components being mounted in a suitable electrically non-conductive housing, they are electrically isolated or floating. Reservoir **40** illustratively is a box-shaped tank **42** covered by a lid **44**.

The switching device **24** is mounted adjacent the floor **48** of the tank **42**, for example, on (a) track(s), rail(s) or other guide means **46**, for movement between the first and second positions **36**, **38**, respectively. In first position **36**, switching device **24** engages and seals port **28** provided in switching device **24** to port **32** provided in a first valve block **50** adjacent one limit of travel of switching device **24**, and seals port **34**, provided in a second valve block **51**, to port **30** provided in switching device **24**. In the second position **38**, switching device **24** engages and seals port **28** provided in switching device **24** to port **34** provided in a third valve block **52** adjacent the other limit of travel of switching device **24**, and seals port **32**, provided in a fourth valve block **53**, to port **30** provided in switching device **24**. Flow of coating material through ports **28**, **30**, **32**, **34** in switching device **24** and valve blocks **50**, **51**, **52**, **53** is controlled by engage-to-open/disengage-to-close valves **54**, such as, for example, the quick couplers of the AquaBlock Mk II voltage block available from Ransburg Industrial Finishing Kabushiki Kaisha, 1-15-5, Fuku-Ura 1 Chome, Kanazawa-Ku Yokohama, Japan 236-0004, the disclosure of which is hereby incorporated herein by reference. This listing is not intended to be a representation that a complete search of all relevant art has been made, or that no more pertinent art than that listed exists, or that the listed art is material to patentability. Nor should any such representation be inferred.

Plumbing for the switching device **24** includes a conduit **56**, a conduit **58**, a conduit **60**, and a conduit **62**. Conduit **56** couples the source **16** and port **28**. Conduit **58** couples reservoir **22***a* and port **32**. Conduit **60** couples reservoir **22***b* and port **34**. Conduit **62** couples port **30** and dispensing device **12**.

Switching device **24** is moved back and forth between the first **36** and second **38** positions by a controller **64** which

controls a motor or actuator means **66** such as, for example, a double-acting, piston-and-cylinder fluid motor. Motor **66** includes an output shaft **68** which is coupled via a tang **70** to switching device **24**. Tang **70** extends between means **66** and switching device **24** through an elongated, slot-shaped opening **72** provided through lid **44**. Elongated, slot-shaped openings **74, 76** are also provided through lid **44** for conduits **56** and **62** to accommodate the motion of switching device **24**. Conduits **56** and **62** are flexible to accommodate this motion.

In operation, reservoir **40** is filled to a level above ports **28, 30, 32, 34**, and typically to within a few centimeters of the top edge of tank **42**, with a blocking medium, such as, for example, the blocking media described in U.S. Pat. Nos. 5,632,816; 5,787,928; 5,746,831; and, 5,944,045. The switching device is moved to its first position **36** and coating material is provided from the source **16** through conduit **56** to port **28**, and through the switching device **24**, port **32** and conduit **58** to reservoir **22***a*. Controller **64** and motor **66** then switch device **24** to its second position **38**. Coating material is provided from source **16** through conduit **56**, port **28**, switching device **24**, port **34** and conduit **60** to reservoir **22***b*. As reservoir **22***b* is being filled, reservoir **22***a* is being emptied through port **32**, switching device **24**, port **30** and conduit **62**, supplying coating material to the dispensing device **12** from which the coating material is dispensed, coating article **18**. As reservoir **22***a* reaches empty, controller **64** and motor **66** switch device **24** back to its first position in which coating material is provided from the source **16** through conduit **56**, port **28**, switching device **24**, port **32** and conduit **58** to reservoir **22***a*. As this is occurring, reservoir **22***b* is being emptied, supplying coating material through conduit **60**, port **34**, switching device **24**, port **30** and conduit **62** to dispensing device **12** from which the coating material is dispensed, coating article **18**, and so on.

Referring particularly to FIG. **3**, the reservoir **40** can include molecular sieves **80** such as, for example, those described in the above identified U.S. Pat. Nos. 5,944,045; 5,787,928; 5,746,831; and, 5,632,816. Illustratively, molecular sieves **80** are placed on the floor **48** of the reservoir **40** underneath switching device **24**. The sieves **80** can be recycled and/or replenished as necessary to maintain their drying action on any water or the like which finds its way into the blocking medium in tank **42**.

What is claimed is:

1. A voltage block comprising first and second reservoirs, a switching device including an inlet port, an outlet port, a first reservoir port and a second reservoir port, the switching device mounted for movement between a first position and a second position in a third reservoir, the third reservoir including an electrically non-conductive fluid medium in which at least a portion of the switching device is immersed.

2. The voltage block of claim **1** including a first valve, a second valve, a third valve and fourth valve, the first, second, third and fourth valves immersed in the electrically non-conductive fluid medium.

3. The voltage block of claim **1** wherein the first and second reservoirs comprise piston-and-cylinder fluid motors.

4. The voltage block of claim **3** wherein the first and second reservoirs together comprise a double-acting, piston-and-cylinder fluid motor.

5. The voltage block of claim **1** wherein the third reservoir comprises a tank including a track to which the switching device is mounted for movement between the first and second positions.

6. The voltage block of claim **5** wherein, when the switching device is in the first position, the first valve couples the inlet port to the first reservoir port and the second valve couples the second reservoir port to the outlet port, and when the switching device is in the second position, the third valve couples the inlet port to the second reservoir port and the fourth valve couples the first reservoir port to the outlet port.

7. The voltage block of claim **1** wherein the third reservoir includes means for movably mounting the switching device, the voltage block further including means for moving the switching device between the first and second positions.

8. The voltage block of claim **1** further comprising molecular sieves in the third reservoir.

9. The voltage block of claim **8** wherein the molecular sieves are renewable.

10. In combination, a coating material source, a coating dispensing device, a high magnitude electrostatic potential source, a voltage block comprising first and second reservoirs, a switching device including an inlet port, an outlet port, a first reservoir port and a second reservoir port, the switching device mounted for movement between a first position and a second position in a third reservoir, the third reservoir including an electrically non-conductive fluid medium in which at least a portion of the switching device is immersed, a conduit for coupling the coating material source and the inlet port, a conduit for coupling the first reservoir and first reservoir port, a conduit coupling the second reservoir and second reservoir port, and a conduit coupling the outlet port and the coating dispensing device.

11. A method of coating an article comprising providing first and second reservoirs, providing a switching device, providing on the switching device an inlet port, an outlet port, a first reservoir port and a second reservoir port, providing a third reservoir including an electrically non-conductive fluid medium, mounting the switching device in the third reservoir for movement between a first position and a second position, and at least partially immersing the switching device in the electrically non-conductive fluid medium in the third reservoir.

12. The method of claim **11** wherein providing a switching device and providing a third reservoir together include providing first, second, third and fourth valves, and at least partially immersing the switching device in the electrically non-conductive fluid medium in the third reservoir includes immersing the first, second, third and fourth valves in the electrically non-conductive fluid medium.

13. The method of claim **11** wherein providing first and second reservoirs comprises providing piston-and-cylinder fluid motors.

14. The method of claim **13** wherein providing first and second reservoirs together comprises providing a double-acting, piston-and-cylinder fluid motor.

15. The method of claim **11** wherein providing the third reservoir comprises providing a tank including a track and providing the switching device includes mounting the switching device on the track for movement between the first and second positions.

16. The method of claim **15** including coupling the inlet port to the first reservoir port through the first valve and coupling the second reservoir port to the outlet port through the second valve when the switching device is in the first position, and coupling the inlet port to the second reservoir port through the third valve and coupling the first reservoir port to the outlet port through the fourth valve when the switching device is in the second position.

17. The method of claim 11 further including movably mounting the switching device and moving the switching device between the first and second positions.

18. The method of claim 11 further including providing a coating material source, a coating dispensing device, a high magnitude electrostatic potential source, coupling the coating material source and the inlet port, coupling the first reservoir and first reservoir port, coupling the second reservoir and second reservoir port, and coupling the outlet port and the coating dispensing device.

19. The method of claim 11 further comprising providing molecular sieves in the third reservoir.

20. The method of claim 19 further comprising renewing the molecular sieves.

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